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ATTORNEY'S DOCKET NUMBER: 5014US

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 09/889773

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/IT99/00422	27 December 1999 (07.12.99)	22 January 1999 (22.01.99)

TITLE OF INVENTION: DEVICE FOR REDUCING ATMOSPHERIC POLLUTION BY EXHAUST GAS

APPLICANT(S) FOR DO/EO/US: PELLEGRINO, Luigi

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [ ] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [X] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information:
    Preliminary Examination Report

NOTICE OF EXPRESS MAILING
Express Mail Mailing Label Number: EL740536839US
Date of Deposit with USPS: 20 July 2001
Person making Deposit: LAWRENCE B. BOND

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/889773	PCT/IT99/00422	5014US

21. The following fees are submitted:	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	23 - 20 =	3	x **$18.00**	$ 54.00
Independent claims	1 - 3 =		x **$80.00**	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$
TOTAL OF ABOVE CALCULATIONS =				$
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$
SUBTOTAL =				$
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$
TOTAL NATIONAL FEE =				$
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$
TOTAL FEES ENCLOSED =				$ 914.00
			Amount to be refunded:	$
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a. ☒ A check in the amount of $ 914.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 20-1469. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

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SIGNATURE

Laurence B. Bond
NAME

30,549
REGISTRATION NUMBER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Luigi Pellegrino

Serial No.: Not yet assigned

Filed: July 20, 2001

For: DEVICE FOR REDUCING ATMOSPHERIC POLLUTION BY EXHAUST GAS

Examiner: Unknown

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PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Please revise the above-identified application as follows:

IN THE CLAIMS:

Claims are presented below in format for publication. Claims 6, 7, 10, 11, 17, 18, 20, 21 and 23 have been amended. Please enter these claims as amended. Attached is Appendix A, which contains a marked-up version of the claims as revised.

1) A device (1; 1′; 1″; 1‴) for reducing atmospheric pollution by exhaust gas, comprising a casing (2) having an inlet (4; 4″, 4‴) for the unpurified exhaust gas, and an outlet (6) for the purified exhaust gas; and scrubbing means (8) housed in said casing (2), interposed between said inlet (4; 4″; 4‴) and said outlet (6), and defining an inner chamber (36) and, together with said casing (2), an outer chamber (34) surrounding said scrubbing means (8); comprising first connecting means (18; 18′; 54,18″) for connecting said outer chamber (34) to said inlet (4; 4″; 4‴); and second connecting means (14-) for connecting said inner chamber (36) to said outlet (6), characterized in that said outer chamber (34) has an annular section decreasing in the flow direction of the exhaust gas.

2) A device (1; 1′) as claimed in Claim 1, characterized in that said first connecting means comprise an annular-section first inlet conduit (18; 18′).

3) A device (1; 1′) as claimed in Claim 2, characterized in that said first inlet conduit (18; 18′) comprises at least a first portion (18a; 18a′) having transverse dimensions increasing towards said outer chamber (34).

4) A device (1; 1′) as claimed in Claim 3, characterized in that said first portion (18a; 18a′) of said first inlet conduit (18; 18′) has a substantially constant exhaust gas passage section.

5) A device (1; 1′) as claimed in Claim 4, characterized in that the exhaust gas passage section of said first portion (18a; 18a′) of said first inlet conduit (18; 18′) is substantially equal to the exhaust gas passage section defined by said inlet (4).

6) (Amended) A device (1; 1′) as claimed in any one of Claim 5, characterized in that said first portion (18a; 18a′) of said first inlet conduit (18; 18′) is defined by a pair of conical walls (10b, 16a; 10b, 16a′) increasing in diameter towards said outer chamber (34) and converging with each other towards the outer chamber (34).

7) (Amended) A device (1; 1′) as claimed in any one of Claim 6, characterized in that said first inlet conduit (18; 18′) also comprises a second portion (18b; 18b′) located downstream from said first portion (18a; 18a′) and having a substantially constant exhaust gas passage section.

8) A device (1) as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b) of said first inlet conduit (18) is substantially equal to the exhaust gas passage section of said first portion (18a).

9) A device (1′) as claimed in Claim 7, characterized in that the exhaust, gas passage section of said second portion (18b′) of said first inlet conduit (18′) is greater than the exhaust gas passage section of said first portion (18a′).

10) (Amended) A device (1; 1′) as claimed in any one of Claim 9, characterized in that said second portion (18b; l8b′) of said first inlet conduit (18; 18′) is defined by a pair of cylindrical walls (10c, 16b; 10c, 16b′) of substantially constant diameter.

11) (Amended) A device (1) as claimed in any one of Claim 8, characterized in that said first inlet conduit (18) also comprises a third portion (l8c) located downstream from said first portion (18a) and having an increasing exhaust gas passage section.

12) A device (1) as claimed in Claim 11, characterized in that said third portion (18c) of said first inlet conduit (18) is defined by a cylindrical outer wall (10c) and by a conical inner wall (16c).

13) A device (1″; 1‴) as claimed in Claim 1, characterized in that said first connecting means (54, 18″) comprise an exhaust gas expansion chamber (54).

14) A device (1″; 1‴) as claimed in Claim 13, characterized in that said first connecting means (54, 18″) also comprise an annular-section second inlet conduit (18″) interposed between said expansion chamber (54) and said outer chamber (34).

15) A device (1″; 1‴) as claimed in Claim 14, characterized in that said second inlet conduit (18″) comprises at least a first portion (18a″) having a substantially constant exhaust gas passage section.

16) A device (1″; 1‴) as claimed in Claim 15, characterized in that the exhaust gas passage section of said first portion (18a″) of said second inlet conduit (18″) is substantially equal to the exhaust gas passage section defined by said inlet (4″; 4‴).

17) (Amended) A device (1″; 1‴) as claimed in Claim 16, characterized in that said first portion (l8a″) of said second inlet conduit (18″) is defined by a pair of cylindrical walls (10a″, l6a″) of substantially constant diameter.

18) (Amended) A device (1″; 1‴) as claimed in any one of Claim 17, characterized in that said second inlet conduit (18″) also comprises a second portion 18b″) located downstream from said first portion (18a″) and having an increasing exhaust gas passage section.

19) A device (1″; 1‴) as claimed in Claim 18, charactertized in that said second portion (l8b″) of said second inlet conduit (18″) is defined by a cylindrical outer wall (10a″) and by a conical inner wall (16b″).

20) (Amended) A device (1″) as claimed in any one of Claim 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4″) has a second axis (B) substantially parallel to said first axis (A).

21) (Amended) A device (1‴) as claimed in any one of Claim 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4‴) has a further axis (C) crosswise to said first axis (A).

22) A device (1‴) as claimed in Claim 21, characterized in that said further axis (C) is perpendicular to said first axis (A).

23) (Amended) A device (1‴) as claimed in Claim 22, characterized in that said further axis (C) is skew with respect to said first axis (A).

REMARKS

No new matter has been added. The Applicant requests entry of the foregoing amendment prior to examination of the application on the merits.

Respectfully submitted,

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APPENDIX A

VERSION WITH MARKINGS TO SHOW CHANGES MADE

6) (Amended) A device (1; 1′) as claimed in any one of Claim[s 3 to] 5, characterized in that said first portion (18a; 18a′) of said first inlet conduit (18; 18′) is defined by a pair of conical walls (10b, 16a; 10b, 16a′) increasing in diameter towards said outer chamber (34) and converging with each other towards the outer chamber (34).

7) (Amended) A device (1; 1′) as claimed in any one of Claim[s 3 to] 6, characterized in that said first inlet conduit (18; 18′) also comprises a second portion (18b; 18b′) located downstream from said first portion (18a; 18a′) and having a substantially constant exhaust gas passage section.

10) (Amended) A device (1; 1′) as claimed in any one of Claim[s 7 to] 9, characterized in that said second portion (18b; l8b′) of said first inlet conduit (18; 18′) is defined by a pair of cylindrical walls (10c, 16b; 10c, 16b′) of substantially constant diameter.

11) (Amended) A device (1) as claimed in any one of Claim[s 3 to] 8, characterized in that said first inlet conduit (18) also comprises a third portion (l8c) located downstream from said first portion (18a) and having an increasing exhaust gas passage section.

17) (Amended) A device (1″; 1‴) as claimed in Claim [15 or]16, characterized in that said first portion (l8a″) of said second inlet conduit (18″) is defined by a pair of cylindrical walls (10a″, l6a″) of substantially constant diameter.

18) (Amended) A device (1″; 1‴) as claimed in any one of Claim[s 15 to] 17, characterized in that said second inlet conduit (18″) also comprises a second portion 18b″) located downstream from said first portion (18a″) and having an increasing exhaust gas passage section.

20) (Amended) A device (1″) as claimed in any one of Claim[s 13 to] 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4″) has a second axis (B) substantially parallel to said first axis (A).

21) (Amended) A device (1‴) as claimed in any one of Claim[s 13 to] 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4‴) has a further axis (C) crosswise to said first axis (A).

23) (Amended) A device (1‴) as claimed in Claim [21 or]22, characterized in that said further axis (C) is skew with respect to said first axis (A).

DEVICE FOR REDUCING ATMOSPHERIC POLLUTION BY EXHAUST GAS

TECHNICAL FIELD

The present invention relates to a device for reducing atmospheric pollution by exhaust gas.

In particular, the present invention may be used to advantage, though not exclusively, for treating exhaust gas produced by any type of internal combustion engine - diesel or Otto cycle, vehicle-mounted or forming part of a fixed installation - or by heating boilers forming part of industrial or civil installations.

BACKGROUND ART

As is known, the exhaust gas produced by internal combustion engines, particularly diesel engines, contains numerous harmful substances, such as unburnt hydrocarbons, particulate, nitrogen and carbon oxides, etc.

Numerous systems and devices have been designed to reduce the atmospheric pollution produced by internal combustion engine exhaust gas.

Such systems and devices normally comprise a hollow casing having an inlet at one end for the unpurified

exhaust gas, and an outlet at the other end for the purified exhaust gas; and scrubbing means interposed between the inlet and outlet.

The scrubbing means used may comprise, for example, a tubular cartridge housed inside the casing and defined by a tubular pad containing purifying mineral fibers and supported by a basket defined by two coaxial tubular bodies of rigid netting between which the pad is interposed.

In cartridge devices of the above type, the unpurified exhaust gas is fed into the cartridge, expands radially through the cartridge and is purified by the mineral fibers inside, comes out, purified, through the outer lateral surface of the cartridge, and is then conveyed to the outlet of the device.

Though particularly advantageous in terms of cost and elimination of contaminating substances, in certain applications, cartridge devices in which the exhaust gas is fed inside the cartridge have several drawbacks preventing maximum benefit of such advantages.

In particular, in applications involving exhaust gas with a high degree of kinetic energy, expansion of the exhaust gas through the cartridge has been found to be fairly aggressive, thus subjecting the pad to far greater mechanical stress and, hence, wear as compared with normal applications.

In such applications, the average working life of the cartridge - by which is meant the length of time the

efficiency of the cartridge is such as to conform with international standards governing the emission of contaminating substances - is therefore considerably shorter than in normal applications, thus resulting in higher costs to continually replace the cartridge.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a device for reducing atmospheric pollution by internal combustion engine exhaust gas, and which provides for a long average working life in any type of application.

According to the present invention, there is provided a device for reducing atmospheric pollution by exhaust gas, comprising a casing having an inlet for the unpurified exhaust gas, and an outlet for the purified exhaust gas; and scrubbing means housed in said casing, interposed between said inlet and said outlet, and defining an inner chamber and, together with said casing, an outer chamber surrounding said scrubbing means; characterized by comprising first connecting means for connecting said outer chamber to said inlet; and second connecting means for connecting said inner chamber to said outlet.

BRIEF DESCRIPTION OF DRAWINGS

A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in

accordance with a first embodiment of the present invention;

Figure 2 shows a section along line II-II in Figure 1;

Figure 3 shows a partial longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in accordance with a second embodiment of the present invention;

Figure 4 shows a longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in accordance with a third embodiment of the present invention;

Figure 5 shows a section along line V-V in Figure 4;

Figure 6 shows a cross section of a device for reducing atmospheric pollution by exhaust gas, in accordance with a fourth embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Figures 1 and 2 show a device for reducing atmospheric pollution by exhaust gas, in accordance with a first embodiment of the present invention.

The device, indicated as a whole by 1, is of the type comprising a hollow, elongated casing 2 having an axis A and, at opposite axial ends, a circular-section inlet 4 for unpurified exhaust gas, and a circular-section outlet 6 for purified exhaust gas; and a tubular cartridge 8 fitted coaxially inside casing 2 and of an outside diameter greater than those of inlet 4 and outlet

6.

Casing 2 comprises three axially connected bodies: a substantially funnel-shaped first end body 10; a substantially truncated-cone-shaped intermediate body 12 housing cartridge 8; and a substantially cup-shaped second end body 14.

A substantially cup-shaped guide body 16 is fitted coaxially inside first end body 10, and defines, with first end body 10, a first annular-section gap communicating with inlet 4 and defining an inlet conduit 18 for the unpurified exhaust gas.

More specifically, first end body 10 comprises a substantially cylindrical first portion 10a defining inlet 4 of the device; a substantially truncated-cone-shaped second portion 10b extending integrally and increasing in diameter from first portion 10a; and a substantially cylindrical third portion 10c extending integrally from second portion 10b.

Guide body 16 comprises a substantially conical first portion 16a internally facing truncated-cone-shaped second portion 10b of first end body 10; a substantially cylindrical, larger-diameter second portion 16b extending integrally from first portion 16a and facing an initial portion of third portion 10c of first end body 10; and a truncated-cone-shaped third portion 16c extending integrally from second portion 16a, facing an end portion of third portion 10c of first end body 10, and decreasing in diameter towards intermediate body 12.

More specifically, truncated-cone-shaped second portion 10b of first end body 10 and conical first portion 16a of guide body 16 converge towards intermediate body 12 so as to define an annular-section exhaust gas passage, which is perpendicular to the flow direction of the exhaust gas, is substantially constant along the whole length of portions 10b, 16a, and is substantially equal to the exhaust gas passage section defined by inlet 4, so as to produce no load losses or noticeable counterpressures.

Preferably, the annular-section exhaust gas passage defined by portions 10b, 16a is 80% to 120% of the passage section defined by inlet 4.

In the flow direction of the exhaust gas from inlet 4 to outlet 6, inlet conduit 18 therefore comprises an initial portion 18a - defined by truncated-cone-shaped portion 10b and conical portion 16a - in which the exhaust gas passage section is substantially constant, is equal to the passage section defined by inlet 4, and has an increasing mean radius, measured with respect to axis A; an intermediate portion 18b - defined by cylindrical portions 10c, 16b - in which the gas passage section is substantially constant, is equal to the passage section defined by portions 10b, 16a, and has a substantially constant mean radius; and an end portion 18c - defined by cylindrical portion 10c and truncated-cone-shaped portion 16c - in which the gas passage section increases and has a decreasing mean radius.

Between first end body 10 and intermediate body 12, a first disk-shaped element 20 of a diameter close to that of first end body 10 is mounted coaxially, and has, on a peripheral annular portion located at the end portion of inlet conduit 18, a number of angularly equally spaced through holes 22 through which the exhaust gas flows from inlet conduit 18 to intermediate body 12.

First disk-shaped element 20 supports coaxially a projecting inner locating collar 24 and a projecting outer locating collar 25, which extend inwards of intermediate body 12, and in which is inserted a first end portion 8a of cartridge 8.

More specifically, the outer locating collar 25 is located at a radially inner annular portion of first disk-shaped element 20 with respect to holes 22; and the inner locating collar 24 is located at an inner annular portion of first disk-shaped element 20.

Intermediate body 12 extends along an extension of first end body 10, and decreases in diameter towards second end body 14.

Intermediate body 12 houses tubular cartridge 8, which comprises a basket 26 - defined by an outer and an inner tubular rigid metal net 28, 30, both coaxial with axis A and preferably formed by stretching high-temperature-resistant stainless steel sheet - and a tubular pad 32 interposed between nets 28, 30.

The outer net 28 is smaller in diameter than the minimum diameter of intermediate body 12, and defines,

together with intermediate body 12, a second annular-section gap in turn defining an outer collecting chamber 34 containing, in use, the unpurified exhaust gas.

More specifically, outer collecting chamber 34 surrounds the whole of cartridge 8, is located coaxially along an extension of inlet conduit 18, communicates with inlet conduit 18 through holes 22, and has an exhaust gas passage section gradually decreasing in the flow direction of the gas.

The inner net 30, on the other hand, defines a cylindrical inner collecting chamber 36 containing, in use, the purified exhaust gas fed radially through pad 32.

Pad 32 comprises a braid of woven threadlike material; and purifying mineral fibers (not shown in detail), e.g. pure silica. The braid and the purifying minerals fibers are wound in a spiral to define, between inlet 4 and outlet 6, substantially alternating layers of threadlike material and mineral fibers.

More specifically, the braid is defined by a number of elastically deformable free meshes, conveniently formed by mechanically weaving stainless steel wire particularly suitable for resisting high temperatures such as that of internal combustion engine exhaust gas.

Second end body 14 comprises a cylindrical first portion 14a connected to intermediate body 12; and an end wall 14b having an axial through hole 46 in which is inserted a cylindrical element 47 extending outwards and

defining outlet 6 of device 1.

A second disk-shaped element 38 is fitted coaxially and in sliding and sealed manner inside second end body 14, is positioned parallel to and a distance from end wall 14b of second end body 14, and has, on an inner annular portion located at inner collecting chamber 36, a number of angularly equally spaced through holes 40 through which the exhaust gas flows from inner collecting chamber 36 to second end body 14.

The gap between second disk-shaped element 38 and the end wall 14b of second end body 14 defines a chamber 48 permitting axial displacement of second disk-shaped element 38 caused by inevitable thermal expansion of cartridge 8 and the various component parts of device 1 during operation of device 1.

Second disk-shaped element 38 supports coaxially a projecting inner locating collar 42 and a projecting outer locating collar 43, which extend towards intermediate body 12, and in which is inserted a second end portion 8b of cartridge 8.

More specifically, the inner locating collar 42 is located at an inner annular portion of second disk-shaped element 38 externally surrounding holes 40; and the outer locating collar 43 is located at a peripheral annular portion of second disk-shaped element 38.

Locating collars 24, 25, 42, 43 retain cartridge 8 axially in the work position by means of a tie 44 coaxial with axis A and connected at opposite ends to disk-shaped

elements 20, 38 in known manner not described in detail.

Tie 44 is made of the same type of material, so as to undergo substantially the same thermal expansion, as nets 28, 30 of basket 26.

The path P traveled, in use, by the exhaust gas between inlet 4 and outlet 6 is shown by the bold line in Figure 1.

More specifically, the exhaust gas is fed into device 1 through inlet 4, and flows along inlet conduit 18 and through holes 22 in first disk-shaped element 20 into outer collecting chamber 34 surrounding cartridge 8, and the gradually decreasing annular section of which assists in forcing the exhaust gas radially through cartridge 8.

The purified exhaust gas then flows into inner collecting chamber 36, from there through holes 40 in second disk-shaped element 38 into second end body 14, and out through outlet 6.

According to the present invention, therefore, the exhaust gas initially occupying a concentrated cylindrical volume defined by inlet 4 is gradually caused to occupy a distributed annular volume defined by outer collecting chamber 34, so that, between inlet 4 and outer collecting chamber 34, most of the kinetic energy of the exhaust gas is dissipated as a result of the following three phenomena:

- distribution of the exhaust gas into a distributed volume at initial portion 18a of inlet conduit 18;

- expansion of the exhaust gas along end portion 18c of inlet conduit 18, where the gas passage section gradually increases; and

- the exhaust gas, as it distributed into outer collecting chamber 34, "skimming" along the inner surface of the chamber.

More specifically, as it is distributed into outer collecting chamber 34, the exhaust gas skims along the inner surface of the chamber, so that, by virtue of Stefan-Bolzmann's (black body) law, the temperature of the exhaust gas is stabilized to a certain extent by radiation towards maximum values of 400-500°C - much lower than those (650°C) of known devices in which the exhaust gas is fed into inner collecting chamber 36 - thus helping to maintain low reoxidation values of the sulfates in the exhaust gas.

Stabilizing the temperature of the exhaust gas towards maximum values of 400-500°C causes a reduction in the heat content of the system and in the specific volume of the exhaust gas as compared with known devices; which factors in turn reduce the impact speed of the exhaust gas against pad 32 of cartridge 8, thus reducing the kinetic energy of the exhaust gas in quadratic proportion to the reduction in speed.

By reducing the kinetic energy of the exhaust gas, radial travel of the exhaust gas through cartridge 8 from outer collecting chamber 34 to inner collecting chamber 36 is therefore less violent, and pad 32 subjected to

considerably less mechanical stress, as compared with conventional devices in which the exhaust gas travels outwards through the cartridge by expansion. As such, the average working life of the cartridges of devices according to the present invention is substantially independent of the application in which the devices are used.

Figure 3 shows a device for reducing atmospheric pollution by internal combustion engine exhaust gas in accordance with a second embodiment of the present invention.

Being substantially similar to device 1, the Figure 3 device, indicated as a whole by 1', will be described only insofar as it differs from device 1, and using the same reference numbers for parts similar or corresponding to those already described.

Device 1' differs from device 1 as regards the shape of the guide body, indicated 16', and hence the shape of the inlet conduit, indicated 18'.

More specifically, guide body 16' comprises a substantially conical first portion 16a' internally facing truncated-cone-shaped second portion 10b of first end body 10; and a substantially cylindrical second portion 16b', which extends integrally from first portion 16a', faces third portion 10c of first end body 10, and has a diameter substantially equal to the radially outer diameter of cartridge 8 (i.e. substantially equal to the radially inner diameter of outer collecting chamber 34).

In the flow direction of the exhaust gas from inlet 4 to outlet 6, inlet conduit 18' therefore comprises an initial portion 18a' - defined by truncated-cone-shaped portion 10b and conical portion 16a' - in which the exhaust gas passage section is substantially constant, is equal to the passage section defined by inlet 4, and has an increasing mean radius, measured with respect to axis A; and an end portion 18b' - defined by cylindrical portions 10c, 16b' - in which the gas passage section is substantially constant, is greater than that defined by portions 10b, 16a', and has a substantially constant mean radius.

Figures 4 and 5 show a device for reducing atmospheric pollution by internal combustion engine exhaust gas in accordance with a third embodiment of the present invention.

Being substantially similar to device 1, the Figure 4 and 5 device, indicated as a whole by 1", will be described only insofar as it differs from device 1, and using the same reference numbers for parts similar or corresponding to those already described.

Device 1" differs from device 1 as regards the shape of the first end body, indicated 10", and the shape of the guide body, indicated 16".

More specifically, first end body 10" is substantially cup-shaped and comprises a cylindrical lateral portion 10a" along an extension of intermediate body 12; and an end wall 10b" having an offset through

hole 50 (i.e. with an axis B parallel to and distinct from axis A) in which is fitted a cylindrical element 52 defining the exhaust gas inlet, indicated in this case by 4".

The gap between the end wall of first end body 10" and first disk-shaped element 20 defines an exhaust gas expansion chamber 54 in which part of the kinetic energy of the exhaust gas is dissipated by expansion.

Guide body 16" is of cylindrical tubular shape, and defines, with first end body 10", an annular-section gap, which communicates with expansion chamber 54 and, through holes 22, with outer collecting chamber 34, and defines an inlet conduit 18" for feeding the unpurified exhaust gas from expansion chamber 54 to outer collecting chamber 34.

More specifically, guide body 16" faces lateral portion 10a" of first end body 10", is separated axially from end wall 10b", and comprises a substantially cylindrical first portion 16a", and a truncated-cone-shaped second portion 16b" extending integrally from first portion 16a" and decreasing in diameter towards intermediate body 12.

In the flow direction of the exhaust gas, inlet conduit 18" therefore comprises an initial portion 18a" in which the exhaust gas passage section is substantially constant, is equal to the passage section defined by inlet 4, and has a substantially constant mean radius; and an end portion 18b" in which the gas passage section

increases and has a decreasing mean radius.

Device 1" operates in substantially the same way as device 1, except that, as opposed to flowing along the initial portion of inlet conduit 18", the exhaust gas is expanded inside expansion chamber 54 to dissipate most of the kinetic energy of the exhaust gas.

Figure 6 shows a device for reducing atmospheric pollution by internal combustion engine exhaust gas in accordance with a fourth embodiment of the present invention.

Being substantially similar to device 1", the Figure 6 device, indicated as a whole by 1"', will be described only insofar as it differs from device 1", and using the same reference numbers for parts similar or corresponding to those already described.

Device 1"' differs from device 1" solely as regards the position of the inlet, indicated 4"', with respect to axis A.

More specifically, as opposed to being formed in end wall 10b" of first end body 10" and having an axis B parallel to and distinct from axis A, inlet 4"' is formed in lateral portion 10a" of first end body 10" and has an axis C perpendicular to and skew with respect to axis A (i.e. not radial and not intersecting axis A).

More specifically, in lateral portion 10a" of first end body 10" and in first portion 16a" of guide body 16", two through holes 58 are formed coaxially with axis C and fitted inside with cylindrical element 52 defining inlet

4"'.

The distance between axes C and A is preferably greater than half the radius of lateral portion 10a" of first end body 10".

The exhaust gas therefore flows into expansion chamber 54 in a direction perpendicular to and not radial with respect to axis A, and flows, inside expansion chamber 54, along a circular path substantially tangent to the inner surface of guide body 16".

This therefore provides, as the exhaust gas expands inside expansion chamber 54, for dissipating a greater amount of kinetic energy as compared with device 1".

The advantages of the devices according to the present invention will be clear from the forgoing description.

Clearly, changes may be made to the devices as described and illustrated herein without, however, departing from the scope of the present invention.

For example, inlet 4"' of device 1"' may be positioned differently from that described, and in particular may be located with axis C perpendicular to and intersecting (i.e. radial with respect to) axis A.

CLAIMS

1) A device (1; 1'; 1"; 1"') for reducing atmospheric pollution by exhaust gas, comprising a casing (2) having an inlet (4; 4", 4"') for the unpurified exhaust gas, and an outlet (6) for the purified exhaust gas; and scrubbing means (8) housed in said casing (2), interposed between said inlet (4; 4"; 4"') and said outlet (6), and defining an inner chamber (36) and, together with said casing (2), an outer chamber (34) surrounding said scrubbing means (8); characterized by comprising first connecting means (18; 18'; 54, 18") for connecting said outer chamber (34) to said inlet (4; 4"; 4"'); and second connecting means (14) for connecting said inner chamber (36) to said outlet (6).

2) A device (1; 1') as claimed in Claim 1, characterized in that said first connecting means comprise an annular-section first inlet conduit (18; 18').

3) A device (1; 1') as claimed in Claim 2, characterized in that said first inlet conduit (18; 18') comprises at least a first portion (18a; 18a') having transverse dimensions increasing towards said outer chamber (34).

4) A device (1; 1') as claimed in Claim 3, characterized in that said first portion (18a; 18a') of said first inlet conduit (18; 18') has a substantially constant exhaust gas passage section.

5) A device (1; 1') as claimed in Claim 4, characterized in that the exhaust gas passage section of said first portion (18a; 18a') of said first inlet conduit (18; 18') is substantially equal to the exhaust gas passage section defined by said inlet (4).

6) A device (1; 1') as claimed in any one of Claims 3 to 5, characterized in that said first portion (18a; 18a') of said first inlet conduit (18; 18') is defined by a pair of conical walls (10b, 16a; 10b, 16a') increasing in diameter towards said outer chamber (34) and converging with each other towards the outer chamber (34).

7) A device (1; 1') as claimed in any one of Claims 3 to 6, characterized in that said first inlet conduit (18; 18') also comprises a second portion (18b; 18b') located downstream from said first portion (18a; 18a') and having a substantially constant exhaust gas passage section.

8) A device (1) as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b) of said first inlet conduit (18) is substantially equal to the exhaust gas passage section of said first portion (18a).

9) A device (1') as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b') of said first inlet conduit (18') is greater than the exhaust gas passage section of said first portion (18a').

10) A device (1; 1') as claimed in any one of Claims 7 to 9, characterized in that said second portion (18b; 18b') of said first inlet conduit (18; 18') is defined by a pair of cylindrical walls (10c, 16b; 10c, 16b') of substantially constant diameter.

11) A device (1) as claimed in any one of Claims 3 to 8, characterized in that said first inlet conduit (18) also comprises a third portion (18c) located downstream from said first portion (18a) and having an increasing exhaust gas passage section.

12) A device (1) as claimed in Claim 11, characterized in that said third portion (18c) of said first inlet conduit (18) is defined by a cylindrical outer wall (10c) and by a conical inner wall (16c).

13) A device (1"; 1"') as claimed in Claim 1, characterized in that said first connecting means (54, 18") comprise an exhaust gas expansion chamber (54).

14) A device (1"; 1"') as claimed in Claim 13, characterized in that said first connecting means (54, 18") also comprise an annular-section second inlet conduit (18") interposed between said expansion chamber (54) and said outer chamber (34).

15) A device (1"; 1"') as claimed in Claim 14, characterized in that said second inlet conduit (18") comprises at least a first portion (18a") having a substantially constant exhaust gas passage section.

16) A device (1"; 1"') as claimed in Claim 15, characterized in that the exhaust gas passage section of

said first portion (18a") of said second inlet conduit (18") is substantially equal to the exhaust gas passage section defined by said inlet (4"; 4"').

17) A device (1"; 1"') as claimed in Claim 15 or 16, characterized in that said first portion (18a") of said second inlet conduit (18") is defined by a pair of cylindrical walls (10a", 16a") of substantially constant diameter.

18) A device (1"; 1"') as claimed in any one of Claims 15 to 17, characterized in that said second inlet conduit (18") also comprises a second portion 18b") located downstream from said first portion (18a") and having an increasing exhaust gas passage section.

19) A device (1"; 1"') as claimed in Claim 18, characterized in that said second portion (18b") of said second inlet conduit (18") is defined by a cylindrical outer wall (10a") and by a conical inner wall (16b").

20) A device (1") as claimed in any one of Claims 13 to 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4") has a second axis (B) substantially parallel to said first axis (A).

21) A device (1"') as claimed in any one of Claims 13 to 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4"') has a third axis (C) crosswise to said first axis (A).

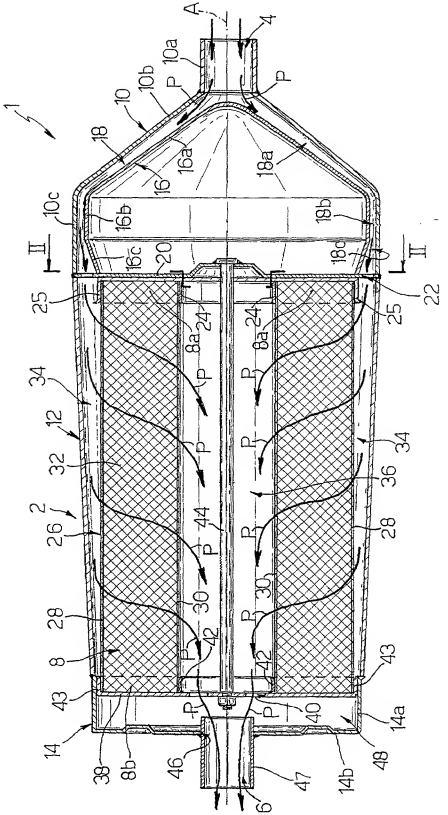
22) A device (1"') as claimed in Claim 21,

characterized in that said third axis (C) is perpendicular to said first axis (A).

23) A device (1"') as claimed in Claim 21 or 22, characterized in that said third axis (C) is skew with respect to said first axis (A).

24) A device (1; 1'; 1"; 1"') as claimed in any one of the foregoing Claims, characterized in that said outer chamber (34) has an annular section decreasing in the flow direction of the exhaust gas.

1 / 3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24
8a
34
12
32
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14b
48
6

Fig.1

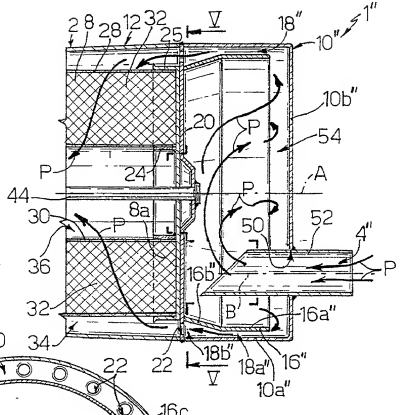


Fig.4

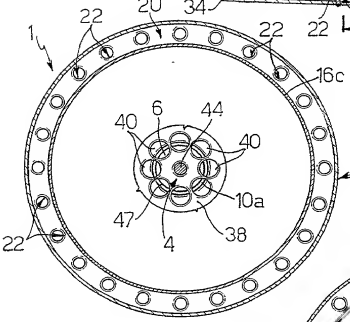


Fig.2

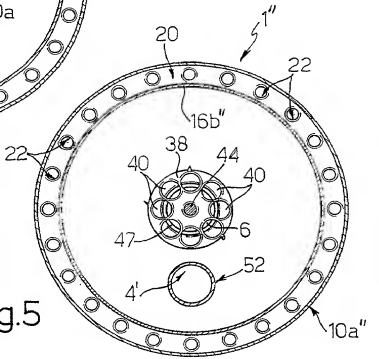
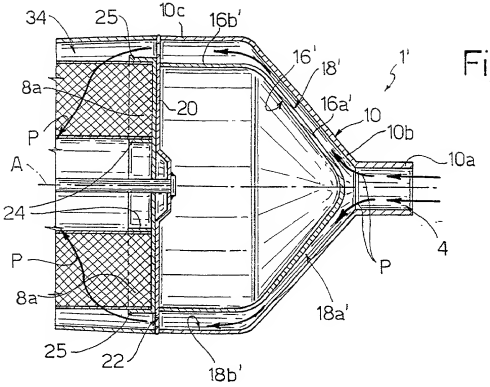


Fig.5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10c
16b'
16'
18'
1'
8a
20
16a'
10
10b
10a
P
A
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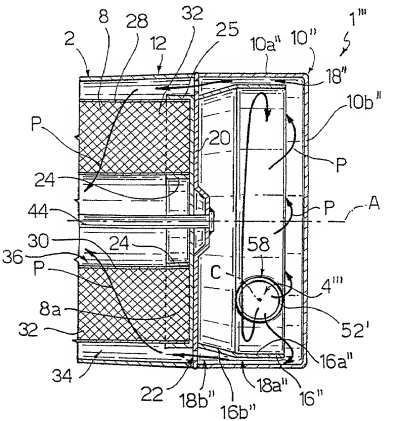
P
8a
18a'
25
22
18b'

Fig.3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18''
10b''
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30
24
58
36
P
C
4'''
8a
52'
32
16a''
34
22
18b''
16b''
18a''
16''

Fig.6

Attorney Docket No. _____

DECLARATION FOR PATENT APPLICATION (WITH POWER OF ATTORNEY)

As an inventor named below or on any attached continuation page, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled "Device for reducing atmospheric pollution by exhaust gas" _____, the specification of which (check one):

is attached hereto.

was filed on _____ as United States application serial no. _____ and was amended on _____.

was filed on _____ as PCT international application no. _____ and was amended under PCT Article 19 on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to the patentability of the subject matter claimed in this application, as "materiality" is defined in Title 37, Code of Federal Regulations ' 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, ' 119(a)-(d) or ' 365(b) of any foreign application(s) for patent or inventor's certificate or ' 365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and on any attached continuation page and have also identified below and on any attached continuation page any foreign application for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America having a filing date before that of the application(s) on which priority is claimed.

Prior foreign/PCT application(s):			Priority Claimed	
PCT/IT99/00422		**27 December 1999**		
			YES	
(number)	(country)	(day/month/year filed)	Yes	No
(number)	(country)	(day/month/year filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, ' 120 of any United States application(s) or ' 365(c) of PCT international application(s) designating the United States of America listed below and on any attached continuation page and, insofar as the subject matter of each of the claims of this application is not disclosed in any such prior application in the manner provided by the first paragraph of Title 35, United States Code, ' 112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations ' 1.56 which became available between the filing date of such prior application and the national or PCT international filing date of this application:

(application serial no.)	(filing date)	(status - pending, patented or abandoned)
(application serial no.)	(filing date)	(status - pending, patented or abandoned)

I hereby claim the benefit under Title 35, United States Code, ' 119(e) of any United States provisional application(s) listed below:

(provisional application no.)	(filing date)

I hereby appoint the following Registered Practitioners to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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